Remarks

Claims 4-10 were pending in the application. In the Office Action, claims 4-10 are rejected. In the instant Amendment, claim 5 has been canceled, without prejudice. Claims 4 and 6-10 have been amended.

Claim 4 has been amended to recite "alloying the steel sheet at 470 to 600°C after the hot dip galvanization". Support for this amendment is found, for example, on p. 11, ll. 20-24 of the specification.

Claim 4 has also been amended to recite "then holding the steel sheet at a temperature of 200°C to 500°C for 1 second to 60 seconds, and the steel sheet is produced in a continuous hot dip galvanization line". Support for this amendment is found, for example, on p.14, ll. 11-14 and on p. 12, ll. 7-11 of the specification.

Claim 4 has further been amended to recite "then cooling the steel sheet at a cooling rate of 5°C/s or higher to 100°C or less so as to avoid further tempering and obtain a metal structure comprised of ferrite and tempered martensite of an area rate of 5% to 60% and the concentration of Fe in hot dip galvannealed area being 7% to 10%". Support for this amendment is found, for example, on p. 9, ll. 29-35 and p. 11, ll. 23-24 of the specification.

In addition, claims 4 and 6-10 have been amended to correct grammatical or editorial errors and to make the claim language clearer. Accordingly, no new matter has been introduced by the present amendment.

Upon entry of the instant Amendment, claims 4 and 6-10 will be pending in the application.

Claim rejection under 35 U.S.C. §103

Claims 4-5 and 7-8 are rejected under 35 U.S.C. §103(a) as being unpatentable over JP 2003-239040 to Mizutani, et al. ("JP '040") in view of JP 06-108152 to Kashima, et al. ("JP '152") for the reasons set forth on pages 3-4 of the Office Action. The rejection is rendered moot as to claim 5 by cancellation of the claim. However, the subject matter of the cancelled claim 5, has been incorporated into claim 4.

While not acquiescing to Examiner's rejection, claim 4 has been amended herein to better describe the production method of a hot dip galvanized composite high strength steel sheet of the present invention. Specifically, claim 4 has been amended to recite: alloying the steel sheet at 470 to 600°C after the hot dip galvanization, then holding the steel sheet at a

temperature of 200°C to 500°C for 1 second to 60 seconds, and the steel sheet is produced in a continuous hot dip galvanization line, and then cooling the steel sheet at a cooling rate of 5°C/s or higher to 100°C or less so as to avoid further tempering and obtain a metal structure comprised of ferrite and tempered martensite of an area rate of 5% to 60% and the concentration of Fe in hot dip galvannealed area being 7% to 10%.

The presently claimed invention is directed to a method for producing a hot dip galvanized composite steel sheet having excellent strength, shapeability and hole enlargement ability. Applicants have found that the desired high strength steel properties are obtained by both limiting the amounts of alloy elements in a steel sheet to the respective recited ranges, and subjecting the steel sheet to the recited process steps.

Further, in the present application, the steel structure comprises a composite of ferrite and martensite structures so as to provide a steel sheet having excellent strength, shapeability and hole enlargement ability. In particular, the claimed steel sheet contains 5 to 60% of tempered martensite. If the area rate of the tempered martensite is less than 5%, the hardness difference between structures becomes too large and no improvement in the hole enlargement rate is seen, while if over 60%, the steel sheet strength drops significantly. This tempered martensite is the tempered martensite structure resulting from the martensite produced in the cooling process after hot dip galvanization for being cooled to the martensite transformation point or less, then being tempered by heat treatment at 200°C to 500°C. Further, the residual austenite is controlled to 5% or less in order to prevent the problems of delayed fracture and secondary work embrittlement. This substantially results in ferrite, martensite, and a tempered martensite structure forming the main phase. The balanced presence of these in the steel sheet is believed to cause the workability and hole enlargement rate to be improved.

Applicants have discovered that 5 to 60% of tempered martensite can be produced by holding the steel sheet for a short period of time, e.g., for at least 1 second and up to 60 seconds, and at a low temperature of 200°C after cooling at a cooling rate of 1°C/s or higher to martensite transformation point or less in temperature. For example, this effect can be obtained by following the steps described below:

-A steel sheet which has been cooled after annealing and has residual austenite, is immersed in a plating bath at a temperature of 450°C to 600°C, and thereafter, a plated layer is alloyed at a temperature of 470°C to 600°C.

-During the alloying process at 470°C to 600°C, carbon atoms in ferrite diffuses into the austenite and are trapped in austenite and do not have time to diffuse out of the structure thereby increasing the C concentration in the austenite.

-Subsequent to the alloying process, the steel sheet under the above condition is cooled (or quenched) to a temperature lower than the martensite transformation temperature, and the austenite is transformed into martensite. Since martensitic transformation does not involve diffusion, the austenite is transformed into martensite while maintaining a high C concentration. Because the holding time in which the steel sheet is immersed in the plating bath is short, diffusion of C rarely occurs during this period.

-Lastly, the martensite containing a high C concentration is tempered. During the tempering process, carbon in the martensite diffuses and thus causes the hardness of the martensite to decrease. The C diffusion occurs more easily in the martensite having a high C concentration than in the martensite having a low C concentration. This is because the tempering is being performed at a low temperature of 200°C and for a short 1 second to 60 seconds.

When using the present production method, duplicate heating involving a further reheating (tempering) step after producing a tempered martensite is avoided. More importantly, the sheet is cooled to the martensite transformation point temperature or less <u>after</u> the hot dip galvanization. If the cooling (or quenching) of the sheet is performed before the plating, then further tempering would occur during the plating step and the desired amount of tempered martensite would not have been obtained. In addition, the tempered martensite of the present invention is produced in a continuous process, e.g., in a continuous hot dip galvanization line, so the productivity of tempered martensite is improved.

JP '040 teaches a molten zinc plating high intensity steel plate excellent in the moldability by regulating the amounts of Si, Mn and Al content in steel, and a manufacturing method for the same.

JP '040, however, does not teach or suggest the production method of tempered martensite of the present invention, specifically in which the steel sheet is produced in a continuous hot dip galvanization line, and that the tempered martensite is produced in a temperature range of 200°C to 500°C with a holding time of at least 1 second. In the Office Action (on page 4), the Examiner acknowledges that JP '040 does not expressly teach the claimed tempering step (e.g., holding at 200 to 500°C for 1 second to 5 minutes). The

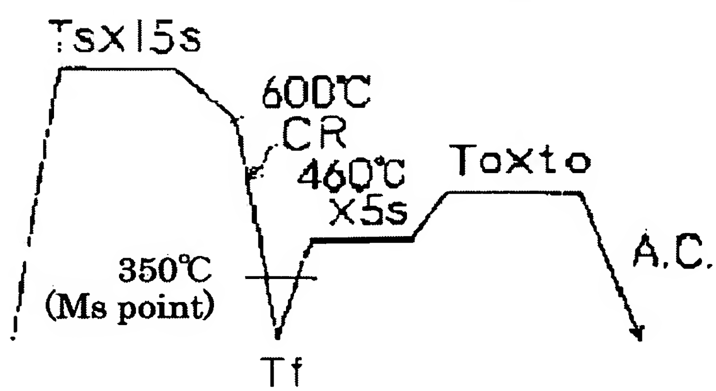
Examiner contends that JP '152 teach a similar method of producing a hot-dip-galvanized high strength steel, with a similar composition, comprises a tempering step, i.e., holding the sheet at 460°C for 5 seconds, during the final cooling step and that it would have been obvious to one of ordinary skill in the art to incorporate the tempering step of JP '152 into the process of JP '040 in order to obtain tempered martensite structure and improve the tensile strength of the steel sheet as taught by JP '152.

JP '152, however, does not teach or suggest the production method of the present invention. JP '152 does not teach the tempering conditions which overlap with those of the present invention. For example, the method of JP '152 includes a step of recrystallization and annealing, a step for performing galvanization, and a subsequent step of reheating at a temperature below Ac1 point and above 250°C (*see* JP '152, at the abstract). As it will be explained below, the sequence of steps for hardening/tempering in JP '152 is different from those described in present application.

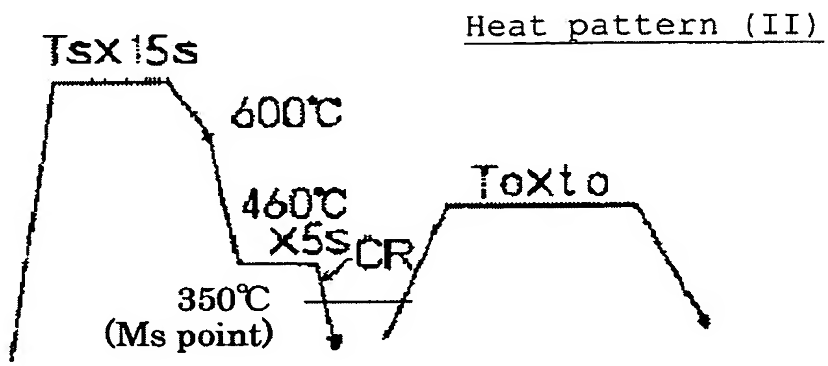
In the example section of JP '152, the obtained cold rolled sheet was heat treated according to three different heat patterns. These specific heat patterns are described in paragraph [0032] of JP '152 and in figures 1 to 3 shown below.

Heat pattern (I): the pattern wherein a recrystallization step, a quenching step, a plating step, and a reheating step are continuously performed.

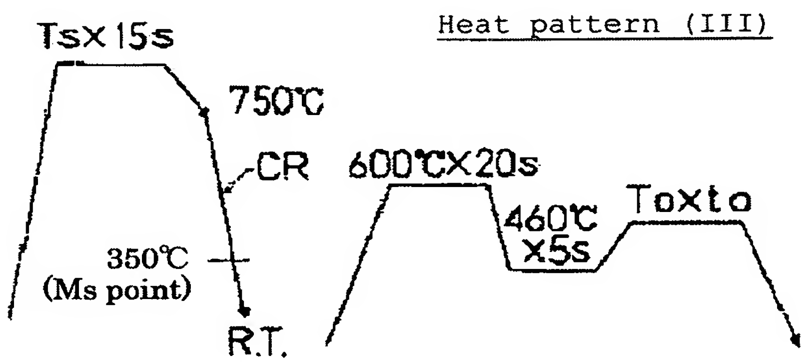
Heat pattern (I)



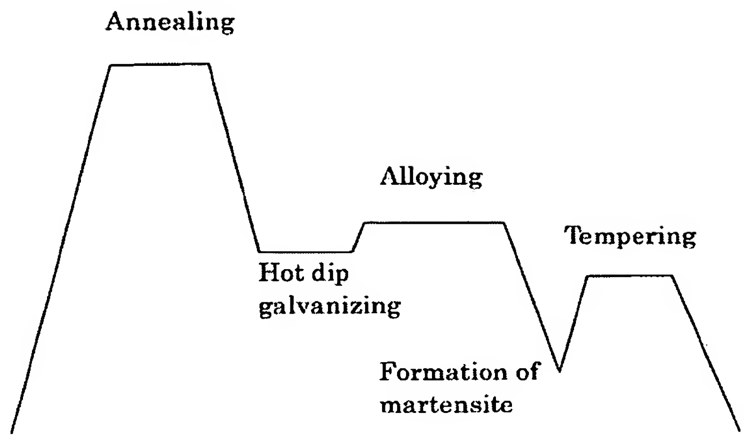
Heating pattern (II): the pattern wherein a recrystallization step, a plating step and a quenching step are continuously performed, and a reheating step is performed in a batch system.



Heating pattern (III): the pattern wherein a recrystallization step and a quenching step are continuously performed, and a plating step and a reheating step are performed in a batch system.



In contrast, in the present invention, a recrystallization and annealing step, a cooling step (not a quenching step), a plating step, an alloying step, a quenching step, and a reheating (tempering) step are performed continuously, as shown in the diagram below.



A feature of the claimed process is that the quenching and reheating (tempering) steps are performed after the plating step and the alloying step, thereby avoiding a further tempering step or over tempering.

In the heat pattern (I) of JP '152, heating is performed in two places, that is, in the plating step after the quenching step and again in the reheating (tempering) step. Therefore over tempering can occur.

In the heat pattern (II), the sequence of the steps is the same as that of the present invention. However, the reheating (tempering) step is performed in a batch system, whereas in the present invention, the reheating is performed in a continuous line of alloying process. Further, JP '152 describes that "this reheating process may be heat treatment for alloying" (*see* paragraph [0024] in JP '152). If an alloying furnace is also used as the tempering furnace, the reheating (tempering) requires 3600 seconds, or 1 hour, which is considered long (*see* Example section of JP '152, e.g., experiments no. 25 to 28), and whereby, over tempering can occur.

In the heat pattern (III), a batch system is also employed. However, similar to the heat pattern (I), reheating (tempering) is performed twice, in the plating step after the quenching step and in the reheating step, and thus, results in over-tempering. Therefore, based on JP '152, thermal treatment for tempering is performed twice, thus a desired amount of tempered martensite cannot be obtained.

None of the heat patterns I, II, and III of JP '152, teach performing a quenching (cooling) step after the alloying process to produce martensite. Thus, the method for

producing martensite in JP '152 is quite different from the presently claimed production method.

Therefore, JP '040 in view of JP '152 cannot render the presently claimed invention obvious. The rejection of claims 4-5 and 7-8 under 35 U.S.C. §103(a) over JP '040 in view of JP ' 152, should be withdrawn.

Claim 6 is rejected under 35 U.S.C. §103(a) as being unpatentable over JP '040 in view of JP '152 as applied to claim 4 above, and further in view of U.S. Patent No. 6,423,426 to Kobayashi, et al. ("US '426") for the reasons set forth on pages 4-5 of the Office Action.

As discussed above, neither JP '040 nor JP '152, taken alone or in any combination, teaches or suggests the present production method. Similarly, US '426 does not teach or suggest the present production method. US '426 teaches the making of a high-strength galvanized steel sheet. US '426 describes in their secondary step that the lath-like martensite produced in the primary step is made to tempered martensite after being subjected to secondary heat treatment, then the steel sheet is cooled to a temperature that is 500°C or lower at a cooling rate of 5°C/sec. or more (*see* US '426, col.8, ll. 14-56). Whereas, in the present production method, the sheets are cooled at a cooling rate of 1°C/sec. or higher, and then holding the sheet at 200 to 500°C for 1 second to 60 seconds. Thus, US '426 does not teach or suggest the claimed tempering step, e.g., holding the sheet at 200 to 500°C for 1 second to 60 seconds.

For at least the reasons presented above, one skilled in the art would not have combined the disclosures of JP '040 and JP '152 with the disclosure of US '426 to arrive at the presently claimed production method of a hot dip galvanized composite high strength steel sheet. Therefore, JP '040 in view of JP '152 as applied to the claims above, and further in view of US '426 cannot render the presently claimed invention obvious. Accordingly, the rejection of claim 6 under 35 U.S.C. §103(a) as being unpatentable over JP '040 in view of JP '152 as applied to claim 4 above, and further in view of US '426 cannot stand and should be withdrawn.

Claims 9-10 are rejected under 35 U.S.C. §103(a) as being unpatentable over JP '040 in view of JP '152 as applied to claim 4 above, and further in view of JP 05-331537 to Deguchi, et al. ("JP '537") for the reasons set forth on page 5 of the Office Action.

JP '537 teaches a method for manufacturing a galvannealed high tensile strength cold rolled steel plate excellent in corrosion resistance and formability. In particular, JP '537 describes heating the sheet for 10 to 300 seconds in a temperature region of an Ac_1-Ac_3 transformation point, and cooling the sheet to a temperature below an Ms (martensite transformation) point with an average cooling rate of not less than 2°C/sec., before introducing into a hot-dip-zincing bath and alloying at 450-600°C after hot dip zincing (*see* paragraph [0006] of JP '537). On the contrary, in the present production method, the sheets are being cooled to a temperature of martensite transformation point or less after the alloying step to produce martensite. Furthermore, JP '537 does not teach or suggest the claimed tempering step, e.g., holding the sheet at 200 to 500°C for 1 second to 60 seconds.

Therefore, for the reasons presented above, one skilled in the art would not have combined the disclosures of JP '040 and JP '152 with the disclosure of JP '537 to arrive at the presently claimed production method of a hot dip galvanized composite steel sheet having excellent strength, shapeability and hole enlargement ability. Therefore, JP '040 in view of JP '152 as applied to the claims above, and further in view of JP '537 cannot render the presently claimed invention obvious. Accordingly, the rejection of claim 9-10 under 35 U.S.C. §103(a) as being unpatentable over JP '040 in view of JP '152 as applied to the claims above, and further in view of JP '537 cannot stand and should be withdrawn.

In view of the foregoing amendments and remarks, Applicants respectfully submit that the present application is in condition for allowance. Early and favorable action by the Examiner is earnestly solicited. If the Examiner believes that issues may be resolved by a telephone interview, the Examiner is invited to telephone the undersigned at the number below.

Respectfully Submitted,

Date: May 5, 2010 By: [signature]

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